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of the moon and of the planets, and also in that of a greater rapidity of approximation by the improvements introduced in these methods.

Laplace, in the *Mécanique Céleste*, alludes to an equation of long period, of which the argument is twice the longitude of the moon's node, plus the longitude of her perigee, minus three times the longitude of the sun's perigee; and M. Poisson has shown that the coefficient of the corresponding argument in the development of the disturbing function equals zero: but the author shows that the same result may be arrived at very simply, by means of the method of developing the variation of the disturbing function.

December 19, 1833.

MARK ISAMBARD BRUNEL, Esq., Vice-President, in the Chair.

A paper was read, entitled, "On the Position of the North Magnetic Pole." By Commander James Clark Ross, R.N., F.R.S.

The author remarks that the discordances in former observations made with a view to determine the position of the magnetic pole, have arisen partly from the irregularity of distribution in the earth of the substances which exert magnetic power, and partly from the great distances from the magnetic poles at which these observations have been made. The latter cause of uncertainty has been now, in a great measure, removed, by the numerous and accurate observations made during the late arctic expeditions. The object of the present paper is to put on record those which were made in the last voyage of Captain Ross, in which a spot was reached corresponding to the true north magnetic pole on the surface of the earth. The nature of the instruments, and the difficulties encountered in their practical employment, under the circumstances of the expedition, are fully stated. Having arrived, on the 1st of June, at north latitude $70^{\circ} 5' 17''$, and west longitude $96^{\circ} 45' 48''$, the horizontal magnetic needle exhibited no determinate directive tendency, and the dipping needle was within a minute of the vertical position, a quantity which may be supposed to come within the limits of the errors of observation; hence the author concludes that this spot may be considered as the true magnetic pole, or as a very near approximation to it, as far, at least, as could be ascertained with the limited means of determination of which he was then in possession.

A table of the observations, including those on the intensity of the magnetic force at various stations, is subjoined.

A paper was also read, entitled, "On the Quantity and Quality of the Gases disengaged from the Thermal Spring which supplies the King's Bath, in the City of Bath." By Charles G. B. Daubeny, M.D., F.R.S., Professor of Chemistry in the University of Oxford.

The author, pursuant to an intention expressed in a former paper read to the Society, undertook a series of experiments, for the purpose of measuring the gas evolved from the thermal springs at Bath during

a period of time sufficiently long to enable him to determine with tolerable precision its average amount, and to ascertain whether any great diurnal variations in its quantity can be detected. He also kept during the same period a corresponding register of the conditions of the atmosphere, as to temperature, humidity and pressure, in order to learn whether any connexion could be traced between these conditions and the quantities of gas evolved. The supplies, both of water and of gas, from the Hot Bath and the Cross Bath being insignificant compared with those from the King's Bath, the author confined his inquiries to the last of these, and chiefly to the gas arising from the apertures within its central area, which is about twenty feet in diameter; the other apertures without this circle from which gas issued being carefully stopped up. The gas was collected by a funnel-shaped apparatus, constructed of several sheets of iron riveted together, and the seams rendered airtight by white lead, supported on a frame, with contrivances for raising and lowering it as occasion might require. The observations were made during periods of from five to fifteen minutes, and continued daily from the 17th of September to the 18th of October inclusive. The average quantity of gas evolved per minute, as deduced from the mean of all the observations, is 267 cubic inches, giving a total daily volume of 223 cubic feet.

The author, by referring to the accounts on record of other thermal waters, concludes that the evolution of gas is a phenomenon as intimately connected with the constitution of these waters, as the presence of a definite quantity of certain saline ingredients, or the possession of a particular temperature; both of which probably continue unaltered for periods of indefinite duration, compared with the records of any human history. He considers this phenomenon to be explicable, by supposing that a large volume of these gases is pent up in some cavern of rock, at a great depth below the surface of the earth, which, at some former period, had been heated by volcanic action, and which, by the gradual cooling and consequent contraction of its external portions, exerts a continued pressure on the gaseous contents of its cavity, and determines the uniform flow of a stream of gas through crevices towards the surface.

It appears from the observations of the author that the quantities of gas disengaged, in a given time, from the King's Bath are somewhat variable; for the differences between the results obtained on successive days are too considerable to be ascribed either to errors of manipulation or to variations in the amount of gas escaping by other avenues. These fluctuations in quantity cannot be traced to have any connexion with those of the atmospheric pressure. Variations likewise were observed in the proportional quantities of carbonic acid contained in the gas evolved at different times, which latter variations the author thinks may perhaps be dependent on the former.

The author remarks, in conclusion, that the immensity of the volume of nitrogen gas which is disengaged from these thermal springs, and the entire absence of carburetted, sulphuretted and phosphuretted hydrogen, seems to afford additional presumption against the truth of the opinion that the nitrogen gas which escapes from volcanoes

and from these springs is derived from atmospheric air, held in solution by the water, and deprived of the greater part of its oxygen by animal and vegetable putrefaction. He is disposed to ascribe the deficiency of oxygen to some process of combustion, during which it unites with some base, forming a compound not easily volatilized by heat; and to account for the presence of carbonic acid, by the calcination of earthy carbonates, rather than by the combustion of coal or bitumen.

The Society then adjourned over the Christmas Vacation, to meet again on the 9th of January.

January 9, 1834.

BENJAMIN COLLINS BRODIE, Esq., Vice-President, in the Chair.

The Earl of Tyrconnel was elected a Fellow of the Society.

A paper was read, entitled, "On the empirical Laws of the Tides in the Port of London, with some Reflections on the Theory." By the Rev. William Whewell, M.A., F.R.S., Fellow and Tutor of Trinity College, Cambridge.

The present state of our knowledge of the tides is represented by the author as extremely imperfect, and at variance with the scientific character which Physical Astronomy is supposed to have attained; for although it be the universally received opinion that they are the direct results of the law of gravitation, the exact laws by which the phenomena are actually regulated with regard to time and place have never been strictly deduced from this general principle. The tide tables that have been given to the world are calculated by empirical methods, which are frequently kept secret by those who employ them; and the mathematical solutions of the problem hitherto attempted have been confessedly founded on hypotheses which are in reality very remote from the real facts; and accordingly it is doubtful whether they give even an approximation to the true result. The comparison of the results of theory with extensive series of observations had not been attempted previously to Mr. Lubbock's discussion of the tides of the port of London, recorded in the *Philosophical Transactions* for 1831. The establishment, on theoretical grounds, of rules for the calculation of tide tables, has been attempted by Bernoulli and by Laplace: the methods recommended by the former are probably the foundation of those at present used by the calculators of such tables, that of Laplace being complicated, and too laborious for practice. Original tide tables are very few; none, with which the author is acquainted, deserving that title, except those which are published for Liverpool, and those for London. The former, which are calculated according to rules obtained from Mr. Holden, from the examination of five years of observations, made at the Liverpool docks by Mr. Hutchinson, at that time harbour-master, are remarkably